

INSTRUCTION MANUAL



Type 1560-P40

Preamplifier

GENERAL RADIO COMPANY

CONTENTS

Specifications

Section 1	Introduction	1
Section 2	Supplying Power for the Preamplifier	3
Section 3	Operating Procedure.	7
Section 4	Service and Maintenance	15
Parts Lists and Schematics		18
Appendix		22

Type 1560-P40 Preamplifier

C

Handbook of Noise Measurement

This 280-page book, by Dr. A. P. G. Peterson and Ervin E. Gross Jr., of the General Radio Engineering Staff, covers thoroughly the subject of noise and vibration measurement. Copies are available from General Radio® at \$1.00 each, postpaid in the United States and Canada.

©GENERAL RADIO COMPANY 1965

West Concord, Massachusetts USA 01781

Form 1560-0260-C

ID-935

January, 1969

specifications

Gain: 1:1 or 10:1 (20 dB) ± 0.3 dB at 25°C; $< \pm 0.3$ dB gain change -50°C to +55°C.

Input Capacitance: 6 pF.

Input Resistance: > 500 M Ω at low audio frequencies.

Output Resistance: 1:1 gain — approx 20 Ω in series with 3.3 μ F.
10:1 gain — approx 100 Ω in series with 3.3 μ F.

Noise: ≤ 2.5 μ V equivalent input voltage (400-pF source impedance, C-weighted, 10-kHz effective bandwidth).

Frequency Response (at 0.5 V pk-pk open-circuit output):

1:1 gain

0°C to 55°C	± 1.5 dB ± 0.25 dB	1 Hz to 500 kHz 3 Hz to 500 kHz
-30°C to 55°C	± 1 dB ± 0.25 dB	5 Hz to 500 kHz 20 Hz to 500 kHz
10:1 gain		
-30°C to 55°C	± 3 dB ± 1.5 dB ± 0.25 dB	3 Hz to 500 kHz 5 Hz to 500 kHz 20 Hz to 250 kHz

Harmonic Distortion at Audio Frequencies:

Open circuit, at 1 V pk-pk: $< 0.25\%$.

Capacitor load of 0.01 μ F (equivalent to a cable over 200 ft long): Max output (pk-pk) at 1% distortion is 5 V for 1 kHz, 2 V for 10 kHz.

Accessories Available

(supplied in combinations listed below):

Power supply, includes two 9.6-V nickel-cadmium rechargeable batteries, a charging circuit, a battery-check light, and a power cord.

Types 1560-P96, 1560-P97, and 1560-P98 Adaptors for converting the input pin connections to 3-terminal shielded microphone connectors, to the pin sockets necessary for the cartridge of a 1560-P3 Microphone, and to a GR874 connector, respectively.

Types 1560-P72 (25-ft), 1560-P72B (100-ft), and 1560-P72C (4-ft) cables for supplying power to and transferring the signal from the preamplifier.

Type 1560-P95 Adaptor Cable for connecting the signal from the power supply through a cable to a double plug.

Type 1560-P99 Adaptor Cable for connection from phone plug to microphone plug.

Power Required: 15 to 25 V, 1 to 2 mA, dc; available from power supply listed below, or from 1558, 1568, and 1564 analyzers, 1525 Recorder, and 1561 Sound-Level Meter.

Dimensions: Length 6 $\frac{7}{8}$, diameter 1.155 by 1 in. (175 x 30 x 26 mm).

Weight: Net, 9 oz (0.3 kg); shipping, 3 lb (1.4 kg), preamplifier only.

Descriptions of the accessories for the preamplifier and a list of the available combination sets are included in the Appendix of this book.

TABLE OF CONTENTS

Section 1. INTRODUCTION	1
1.1 Purpose	1
1.2 Mechanical Description	1
1.3 Electrical Description	2
Section 2. SUPPLYING POWER FOR THE PREAMPLIFIER	3
2.1 General	3
2.2 Type 1560-4100 Power Supply	3
2.3 Power Supplied by Type 1551-C Sound-Level Meter or Type 1553-A Vibration Meter	5
2.4 Power Supplied by Type 1558 Octave-Band Noise Analyzer	5
2.5 Power Supplied by Type 1564-A Sound and Vibration Analyzer	5
Section 3. OPERATING PROCEDURE	7
3.1 Microphone or Adaptor Attachment	7
3.2 Microphone-Sensitivity Correction	8
3.3 Electrical-Signal Measurements	9
3.4 Acoustic Measurements	12
3.5 Vibration Measurements	13
3.6 Other Applications	14
Section 4. SERVICE AND MAINTENANCE	15
4.1 Warranty	15
4.2 Service	15
4.3 Servicing	16
PARTS LISTS and SCHEMATICS	18
APPENDIX	22

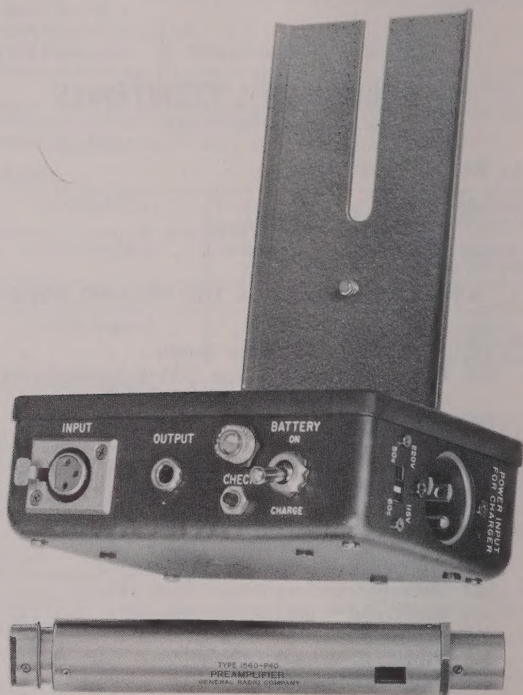


Figure 1-1. Type 1560-P40 Preamplifier with
Type 1560-4100 Power Supply and mounting bracket.

SECTION 1

INTRODUCTION

1.1 PURPOSE.

The Type 1560-P40 Preamplifier (Figure 1-1) is a low-noise amplifier designed to couple a microphone to a coaxial cable without loss or with a voltage gain of 10 to 1. It is also useful as a calibrated preamplifier of signals to analyzers, voltmeters, recorders, sound-level meters, and other such instruments. With the adaptors supplied and available, nearly all types of connectors can be connected to the input of the preamplifier.

A shielded battery power supply, Type 1560-4100 (Figure 1-1) is available to supply power to the Type 1560-P40 Preamplifier for those applications where no other suitable source of power is available.

1.2 MECHANICAL DESCRIPTION.

1.2.1 PREAMPLIFIER.

The preamplifier is housed in a one-inch-diameter tube that is finished in brushed chrome. A one-inch hexagonal section on one end prevents the preamplifier from rolling when it is placed on a flat surface. When a microphone is mounted directly on the input end of the preamplifier, diffraction and reflection of acoustic energy are minimized by the small diameter of the tube.

The cartridge of the General Radio Type 1560-P5 Microphone can be attached directly to the input end of the preamplifier. A groove on the end piece enables the preamplifier and microphone to be attached to the General Radio Type 1559-A or -B Microphone Reciprocity Calibrator for direct acoustical calibration of the microphone and preamplifier or of the complete measurement system. An adaptor is available to mount the cartridge of the Type 1560-P3 Microphone solidly on the preamplifier without inserting a three-terminal microphone connector between the

cartridge and the preamplifier input terminals. Also, this combination of microphone, adaptor, and preamplifier can be attached to the Type 1559-A or -B Microphone Reciprocity Calibrator. Other adaptors are available to adapt the input to three-terminal microphone connectors and to the GR874 Coaxial Connectors. Thus, by means of the various GR874 Adaptors, it is possible to connect the input end of the preamplifier to almost any available type of connector.

1.2.2 POWER SUPPLY.

The Type 1560-4100 Power Supply includes two nickel-cadmium rechargeable batteries, a battery-charging circuit, and a battery-checking circuit, all enclosed in an aluminum case. The controls (see Figure 1-2) include a toggle switch (engraved BATTERY ON and CHARGE), a push-button switch (engraved BATTERY CHECK) with an indicator lamp, and a recessed slide switch to set to the correct power-line voltage for battery charging. A bracket is supplied to attach the power supply to any of several portable GR instruments.

The power supply is available with the preamplifier in the Type 1560-P40H Preamplifier and Power Supply Set, which includes the necessary adaptors and cables. (Other available sets are listed on page 23).

1.3 ELECTRICAL DESCRIPTION.

Two pins of a three-terminal microphone connector at the output end of the preamplifier connect to the preamplifier output; the third pin is used to feed power to the circuit.

The active elements of the preamplifier are: one N-channel, field-effect transistor and two conventional transistors. The field-effect transistor, specially selected for low noise, is connected as a source follower and feeds the two conventional transistors, which are connected as a negative-feedback pair. The feedback is switched to provide a voltage gain of either 1 or 10.



Figure 1-2. Type 1560-4100 Power Supply showing panel controls and method of attaching bracket.

SECTION 2

SUPPLYING POWER FOR THE PREAMPLIFIER

2.1 GENERAL.

The power required by the preamplifier is 15 to 25 volts at 1 or 2 milliamperes. Types 1558-A, AP, and BP Octave-Band Noise Analyzers, and the Type 1564-A Sound and Vibration Analyzers of current manufacture are designed to provide the power necessary for the Type 1560-P40 Preamplifier from their three-terminal input connectors. The preamplifier can be plugged directly into the connector, or a two-conductor shielded cable, such as those of the Type 1560-P72 series, can be used. Older instruments of the above types, and the Type 1551-C Sound-Level Meter and the Type 1553-A Vibration Meter do not ordinarily supply the required power, but they can be modified as described below (refer to paragraphs 2.3 through 2.5).

2.2 TYPE 1560-4100 POWER SUPPLY.

2.2.1 BATTERY CHARGING.

Always check the battery voltage before using the Type 1560-4100 Power Supply to power the Type 1560-P40 Preamplifier. Set the BATTERY toggle switch to ON. Push the BATTERY CHECK switch. If the indicator lamp does not light, or if it glows for only a short time, the batteries should be recharged. The indicator lamp will not light when the battery voltage drops below 16 volts.

To charge the batteries, set the power-line switch to the voltage and frequency of the available power line. Connect the power supply to the line using the cord provided, then set the toggle switch to CHARGE. Discharged batteries can be fully recharged in 14 to 16 hours.

NOTE

If the power-line rating is 115 volts and 50 c/s instead of 60 c/s, the battery charging current will be low; discharged batteries can be fully recharged in 17 to 20 hours. The charging current can be increased to the nominal 22 mA by changing resistor R501 (Figure 4-1) to 1800 ohms, 2 watts.

If the power-line rating is 230 volts and 60 c/s instead of 50 c/s, the charging current will be too high. Resistor R505 (Figure 4-1) must be increased to 9100 ohms, 5 watts, if frequent recharging at this line voltage and frequency is necessary.

2.2.2 USE OF THE POWER SUPPLY.

The output connector of the Type 1560-P40 Preamplifier can be plugged directly into the INPUT socket of the Type 1560-4100 Power Supply or connected to it with a two-conductor shielded cable. Power is applied to the preamplifier when the BATTERY switch is in the ON position; the power is disconnected when the switch is in the CHARGE position.

The output signal from the preamplifier is accessible at the OUTPUT phone jack on the power supply. The jack can be connected to Type 938 Binding Posts by means of the Type 1560-P95 Cable, or to a three-terminal microphone connector by means of the Type 1560-P99 Cable. A Type 874-Q2 Adaptor, with a Type 1560-P95 Cable, makes it possible to connect the phone jack to a GR874 Coaxial Connector.

2.2.3 ATTACHING THE POWER SUPPLY.

The Type 1560-4100 Power Supply can be attached to several portable General Radio instruments by means of the bracket that is supplied. The procedure is as follows:

- a. Remove the four screws that fasten the bottom plate to the power supply.
- b. Place the flat plate section of the bracket over the bottom plate, with the slotted leg to the rear (see Figure 1-2), and fasten the two plates to the power supply with the four screws.
- c. Lock the Flip-Tilt cover of the instrument to which the power supply is to be attached in the fully open position.
- d. Place the power supply beside the instrument, with the slot in the bracket over the tripod socket on the cover of the instrument. Clamp the bracket in the desired position; use the thumbscrew supplied. With the adaptor provided, the thumbscrew may be used with either a 1/4- or 3/8-inch tripod socket.

2.3 POWER SUPPLIED BY TYPE 1551-C SOUND-LEVEL METER OR TYPE 1553-A VIBRATION METER.

The Type 1551-C Sound-Level Meter and the Type 1553-A Vibration Meter are not normally provided with this power capability. However, it can be added if required, preferably by a General Radio service facility. For more detailed information about this modification, write or phone the nearest General Radio sales-engineering office.

2.4 POWER SUPPLIED BY TYPE 1558 OCTAVE-BAND NOISE ANALYZER.

Type 1558-A or -AP Octave-Band Noise Analyzers supplied prior to August, 1964, are not wired to provide power for the preamplifier. These instruments will be modified, without charge, at any General Radio sales office that includes a service facility (see back cover), to provide the required power at the input connector. The modification can be made by connecting a lead from the positive end of capacitor C501 to terminal #2 of the MIKE socket (refer to the Operating Instructions for the Type 1558 Octave-Band Noise Analyzers, Figures 4-3 and 4-7).

2.5 POWER SUPPLIED BY TYPE 1564-A SOUND AND VIBRATION ANALYZER.

Type 1564-A Sound and Vibration Analyzers supplied prior to February, 1965, are not wired to supply power for the preamplifier. It is recommended that these instruments be returned to a General Radio sales-engineering office that includes a service facility, for no-charge modification to provide the required power. However, a modification kit consisting of a lead, a resistor (240 ohms $\pm 5\%$, 1/4 watt), and a transistor (Type 2N697) will be supplied without charge by any General Radio sales-engineering office.

Figure 2-1 shows the placement of the resistor and lead. Solder one end of the resistor to terminal #2 of the INPUT socket. Connect the lead from the other end of the resistor to the etched-board lead that connects to the emitter of transistor Q505. Replace this transistor with the Type 2N697 transistor supplied in the modification kit.

2.6 OTHER INSTRUMENTS.

The dc power to operate the Preamplifier can be obtained directly from the Type 1505 Wave Analyzer, Type 1525 Data Recorder and the Type 1561 Precision Sound-Level Meter.

CAUTION

Terminal #2 is connected to ground (terminal #1) on the connectors of some microphones, accelerometers, control boxes, and cables supplied by General Radio prior to January, 1962. If necessary, remove the connection between pins #1 and #2 before the above connectors are plugged into any other connector that supplies power through pin #2.

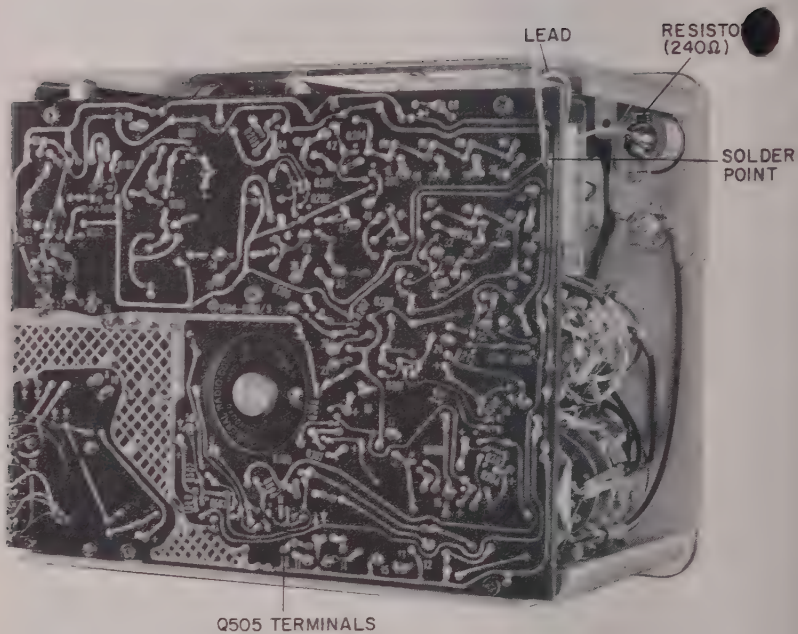


Figure 2-1. Modification of Type 1564-A Sound and Vibration Analyzer for use with the preamplifier.

SECTION 3

OPERATING PROCEDURE

3.1 MICROPHONE OR ADAPTOR ATTACHMENT.

The cartridge of the Type 1560-P5 Microphone and the Types 1560-P96, -P97, and -P98 Adaptors can be locked to the preamplifier by backing out two shouldered screws against the cartridge or the adaptor. Use the following procedure:

- a. Turn in the two screws (A, Figure 3-1), using the hexagonal wrench provided.
- b. Plug the microphone or adaptor onto the preamplifier so that the red dots (engraved on the sides of each) are aligned.
- c. Back out the two screws so that their tips extend through the holes in the microphone or adaptor and their shoulders press firmly against the shell.

If the Type 1560-P3 Microphone is to be used with the preamplifier, it can be attached by use of the Type 1560-P96 Adaptor for three-terminal microphone connectors; or the microphone cartridge can be removed from the connector section and attached to the Type 1560-P97 Adaptor. The latter combination is preferable, because it eliminates the electrical noise development that may occur in the three-terminal connectors when they are used in a high-impedance circuit.

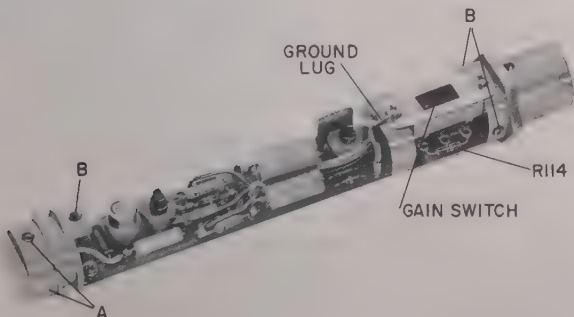


Figure 3-1. Interior view of the preamplifier.

To attach the microphone cartridge to the Type 1560-P97 Adaptor, proceed as follows:

- a. Remove the three screws that attach the microphone cartridge to the Type 1560-P3 Microphone.
- b. Lift off the cartridge; unclip the leads from the two connecting pins on the cartridge.
- c. Plug the cartridge onto the Type 1560-P97 Adaptor and fasten with the three screws removed in step a.

If the microphone cartridge is reassembled on the three-terminal microphone connector, the two pins must be connected correctly. Connect the lead from connector pin #1 to the grounded pin (no insulator) of the microphone cartridge.

NOTE

Cartridges for the Type 1560-P3 Microphones that have connecting leads instead of pins on the cartridge cannot be used with the Type 1560-P97 Adaptor.

3.2 MICROPHONE-SENSITIVITY CORRECTION.

When a microphone and preamplifier are used in conjunction with a Type 1551-C Sound-Level Meter, a Type 1558-A Octave-Band Noise Analyzer, or a Type 1564-A Sound and Vibration Analyzer, the effective sensitivity of the microphone is increased. This increase is brought about because the voltage loss caused by the preamplifier input-capacitance load on the microphone is less than that caused by the input-capacitance load of the above instruments. Also, when a cartridge from a Type 1560-P4 or -P6 Microphone Assembly is used, the loss caused by the capacitance of the flexible arm is not present. (The sensitivity given for a Type 1560-P4 or -P6 Microphone Assembly is for the combined microphone cartridge and flexible arm.)

To calibrate a system of microphone, preamplifier, and one of the above-named instruments, a Type 1552-B Sound-Level Calibrator or a Type 1559-B Microphone Reciprocity Calibrator is recommended. Alternatively, the correction data given in Table 3-1 can be used to correct the

TABLE 3-1

MICROPHONE-SENSITIVITY CORRECTION IN DECIBELS

Microphone Cartridge	Measuring Instrument		
	Type 1551-C	Type 1558-A, -AP	Type 1564-A
Type 1560-P3 or -P5	0.9	1.0	1.4
Type 1560-P4 or -P6	1.5	1.6	2.1

sensitivity value given for the particular microphone being used. Add the correction algebraically to the specified microphone sensitivity value to obtain the effective sensitivity value. This corrected value can then be used to calibrate the measuring instrument, as directed in the Operating Instructions for the latter. If a Type 1552-B Sound-Level Calibrator is used to calibrate the system, the gain of the preamplifier should be set at X1, to prevent its possible overload (see Figure 3-1). If the system is calibrated with a Type 1559-B Microphone Reciprocity Calibrator, the preamplifier gain may be set at either X1 or X10.

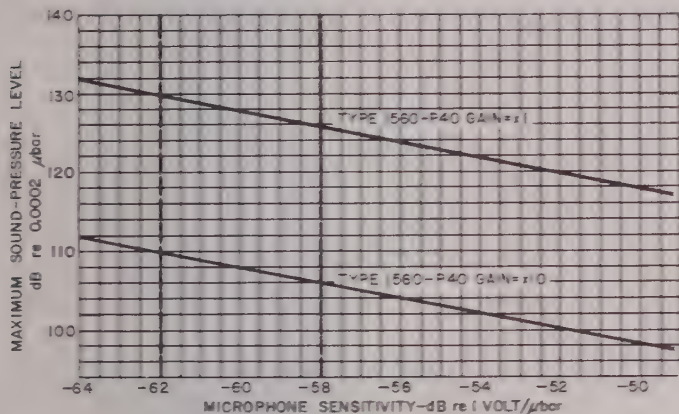


Figure 3-2. Maximum sound-pressure level that can be measured with a Type 1560-P40 Preamplifier and microphone combination. The sensitivities of Types 1560-P3, -P4, -P5, and -P6 Microphones will fall between the dotted lines. Allowance is made for a peak-to-rms ratio of 14 dB. For a sine-wave acoustic signal, the maximum level can be increased by 11 dB.

3.3 ELECTRICAL-SIGNAL MEASUREMENTS.

3.3.1 GENERAL.

Connect the preamplifier to its source of power (refer to Section 2) and connect the input signal to the preamplifier by means of the correct adaptor. Set the gain switch (see Figure 3-1) to the desired gain, either X1 or X10, as engraved on the switch.

NOTE

When power is applied to the preamplifier, about one-half minute is required for the input stage to stabilize and for the preamplifier to operate.

With a high-impedance load on the preamplifier, audio-frequency voltage up to 0.5 volt peak-to-peak at X10 gain or 5 volts peak-to-peak at X1 gain may be applied to the preamplifier input.

Because of the low output impedance of the preamplifier, a long cable may be used between the preamplifier and the measuring instrument. At X10 gain, up to one-half mile of cable may be used; at X1 gain, up to one mile is satisfactory. Figure 3-3 shows the attenuation versus frequency for three different lengths of cable. The fixed loss for each length

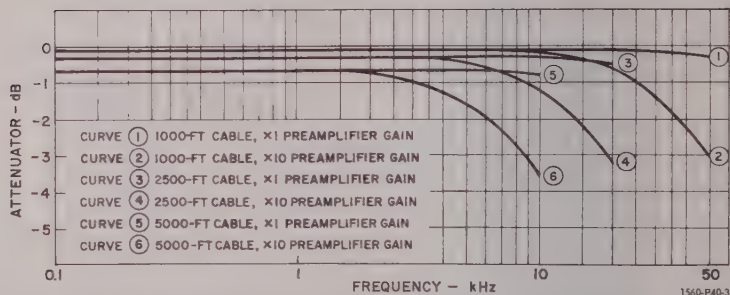


Figure 3-3. Attenuation of the preamplifier output signal caused by the capacitance of the cable between the preamplifier and the measuring instrument.

is caused by the divider formed by the preamplifier output coupling capacitor and the cable capacitance. When a long connecting cable is used, output from the preamplifier may have to be restricted because of the low reactance load of the cable. Figure 3-4 shows cable length versus maximum voltage output at three different frequencies, for a maximum distortion of 1%. The maximum sound-pressure level that should be measured is also shown.

A restricting factor in the use of long cables is the fact that as the length of a cable terminated in a high impedance approaches $1/4$ wavelength of the electrical-signal frequency, the amplitude and transient response at the output end will be considerably distorted.

Figure 3-5 gives the noise level of the preamplifier in the form of curves of typical values for the e_n and i_n generators versus frequency.

Figures 3-6 and 3-7 give the phase shift in the amplifier as a function of frequency.

3.3.2 GROUNDING.

Normally, the low side of the preamplifier circuit is connected to the shell, which may be grounded by the ground of the measuring system. Occasionally, however, problems arise from multiple ground loops caused by grounds at different points in a system. As an aid in solving such special problems, the grounding connection from the preamplifier circuit to the shell can be disconnected easily. Remove the cylindrical tube from

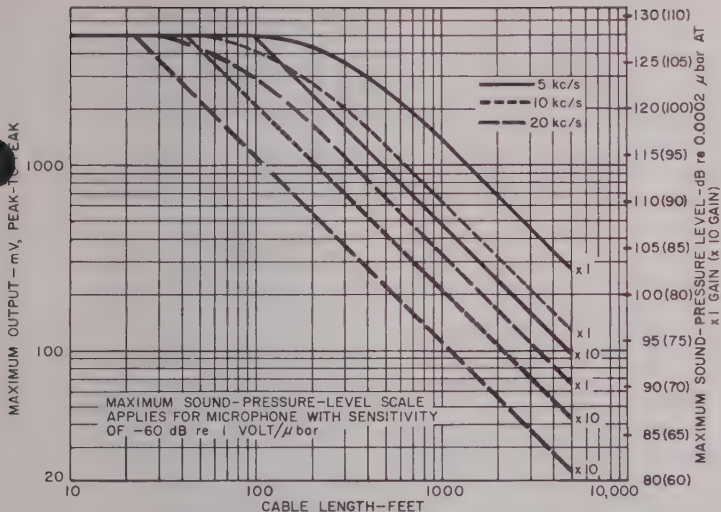


Figure 3-4. Curves showing the maximum output for a maximum distortion of one percent when a long cable terminated in a high-impedance load is driven. Allowance is made on the maximum sound-pressure-level scale for an acoustic waveform having a peak-to-rms ratio of 14 dB. With a sine-wave signal, the maximum sound-pressure level can be increased by 11 dB.

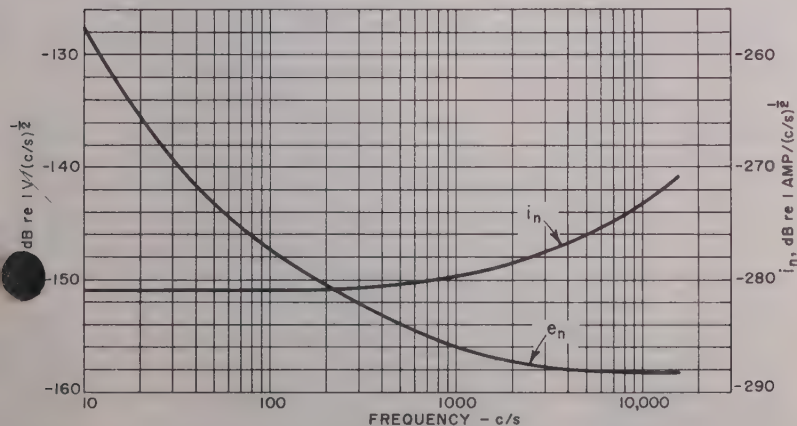


Figure 3-5. Typical frequency spectra of internal noise.

the preamplifier (refer to paragraph 4.3.2). Then remove the screw holding the ground lug at the end of the gain switch (see Figure 3-1). Bend the connecting lead so that the lug can not contact the shell or any part of the circuit. Then replace the screw. Also, be sure that the circuit is not grounded to the shell by the input or output connector. If cable connections are used, a two-conductor shielded cable for the input and a three-conductor shielded cable for the output are required. The shield must connect to the shell. The low side of the preamplifier circuit connects to terminal #1 of the three-terminal output plug.

3.4 ACOUSTIC MEASUREMENTS.

In acoustic measurements, the preamplifier can be used to increase by 20 dB the sensitivity of the Types 1558-A, 1558-AP, and 1564 Analyzers. In conjunction with the preamplifier, these instruments can be used for measurements down to a sound-pressure level of 24 dB re .0002 μ bar.

The preamplifier is also useful with the Type 1551-C, 1561, and 1561-R Sound-Level Meters, as well as with the above instruments, when a long cable must be used. The preamplifier eliminates the loss caused by a long cable used directly after a microphone (refer to paragraph 3.3.1).

The 1569 Automatic Level Regulator can also be used with the preamplifier.

Attach the microphone to the preamplifier as described in paragraph 3.1. Connect the preamplifier to its power source and to the measuring instrument (which may also be the power source; refer to paragraphs 2.3 through 2.5). Slide the gain switch (see Figure 3-1) to the desired gain, X1 or X10, as engraved on the switch. When the gain is X10, subtract 20 dB from the decibel reading of the measuring instrument to obtain the noise level at the microphone.

When a cable is used to connect them to the measuring instrument, the preamplifier and microphone can be mounted on the Type 1560-P32 Tripod. The measuring instrument and the observer can then be located at the other end of the cable, far enough removed from the acoustic field to have little or no effect on the accuracy of the measurement.

When a short connecting cable, or none at all, is used, the maximum noise level that can be measured without the possibility of overloading the amplifier is given in Figure 3-2. Allowance is made for a peak-to-rms ratio of 14 dB, which is adequate for normal noise.

When a long connecting cable is used, the maximum noise level that should be measured is given in Figure 3-4. The maximum value obtained from the figure will usually be pessimistic for broadband noise measurements, since the high-frequency components of such noise usually are of lower level than the low-frequency components.

For a complete discussion of the techniques of noise measurement, refer to the General Radio Handbook of Noise Measurement.

NOTE

When the preamplifier-and-microphone assembly is used, particularly when low sound levels are measured, the assembly should be protected from mechanical vibration, such as that caused by rubbing against another object. The vibration is transmitted through the mechanical structure to the microphone, and the resulting electrical signal from the microphone may cause a large error in the measurement.

3.5 VIBRATION MEASUREMENTS.

The preamplifier can be used to advantage with the Type 1553 Vibration Meter and the Type 1564-A Sound and Vibration Analyzer for vibration measurement and analysis. It permits the use of long cables without loss and increases the sensitivity of the measuring instrument by 20 dB.

Attach the Type 1560-P96 Adaptor to the preamplifier as described in paragraph 3.1. Plug the vibration-pickup cable into the adaptor. Connect the preamplifier to its power source and to the measuring instrument (refer to paragraphs 2.3 through 2.5). Slide the gain switch to the desired gain (X1 or X10). If the preamplifier is used at X10 gain, divide the readings of the measuring instrument by 10. If readings are taken in decibels, subtract 20 dB. Allowance is made for a peak-to-rms ratio of approximately 15 dB. For a sine-wave vibration signal, the maximum g values given can be multiplied by 4.

Table 3-2 lists the maximum vibration acceleration that should be measured when General Radio vibration pickups are used with the Type 1560-P40 Preamplifier.

The Type 1557-A Vibration Calibrator can be used to calibrate the Types 1560-P52 and -P53 Pickups with either X1 or X10 preamplifier gain. The Type 1560-P54 Pickup should be calibrated only with X1 gain.

3.6 OTHER APPLICATIONS.

The preamplifier provides added sensitivity, at a very high input impedance, to a wide variety of instruments. These instruments are listed in Table 3-3. The Type 1560-4100 Power Supply is required when the preamplifier is used with any of these instruments.

TABLE 3-2
MAXIMUM VIBRATION ACCELERATION
TO BE MEASURED WITH VARIOUS PICKUPS.

<i>Pickup</i>	<i>X1 Preamplifier Gain</i>	<i>X10 Preamplifier Gain</i>
Type 1560-P52	5.5 g	0.55 g
Type 1560-P53	5.5 g	0.55 g
Type 1560-P54	0.7 g	0.070 g

TABLE 3-3

**INSTRUMENTS WITH WHICH
THE TYPE 1560-P40 PREAMPLIFIER
(WITH THE TYPE 1560-4100 POWER SUPPLY)
CAN BE USED FOR ADDED SENSITIVITY.**

<i>Type No.</i>	<i>Name</i>
1900-A	Wave Analyzer
*1565-A	Sound-Level Meter
1142-A	Frequency Meter and Discriminator
1232-A	Tuned Amplifier and Null Detector
1521-B	Graphic Level Recorder
1806-A	Electronic Voltmeter

*Use a 1560-P96 Adaptor at input to 1565-A; connect a 390-PF $\pm 5\%$ capacitor in series with lead to #3 input terminal.

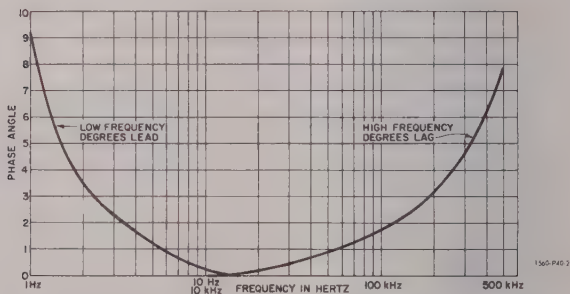


Figure 3-6. Phase shift in the 1560-P40 Preamplifier at 0 dB gain. High-impedance load.

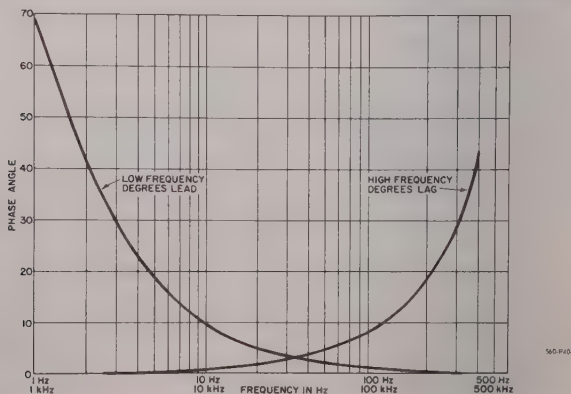


Figure 3-7. Phase shift in the 1560-P40 Preamplifier at 20 dB gain. High-impedance load.

SECTION 4

SERVICE AND MAINTENANCE

4.1 WARRANTY.

We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, sales-engineering office, or authorized repair-agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

4.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest sales-engineering office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

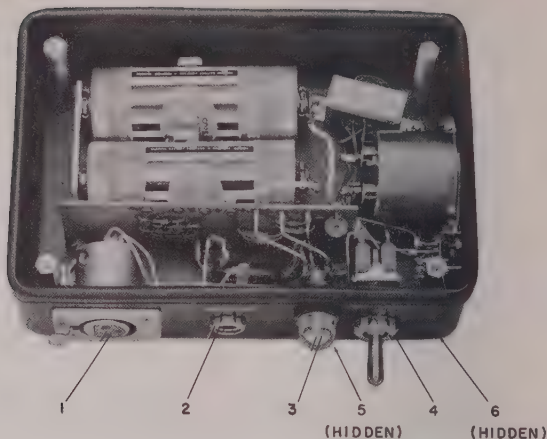


Figure 4-1. Interior view of the power supply.

4.3 SERVICING.

4.3.1 TYPE 1560-4100 POWER SUPPLY.

Remove the four screws that attach the bracket and the cover plate and remove the bracket and plate. Figures 4-1 and 4-4 show the locations of all components.

Table 4-1 gives the normal voltage from each transistor terminal to ground. Depress the BATTERY CHECK button. Measure the voltages with a vacuum-tube voltmeter and with a battery voltage of about 21 volts (nearly fully charged). A 10-percent deviation from the listed values is allowable.

At nominal line voltage (marked on the case, near the line-voltage switch), the battery-charging current should be 22 milliamperes $\pm 10\%$. Measure the current with an average-reading dc meter.

TABLE 4-1

POWER SUPPLY TRANSISTOR VOLTAGES.

<u>Transistor</u>	<u>Terminal</u>	<u>Dc Volts to Ground</u>
Q501	COLLECTOR	6.9
	BASE	7.4
	EMITTER	6.8

4.3.2 TYPE 1560-P40 PREAMPLIFIER.

Using the hexagonal wrench provided, screw in the three shouldered screws (B, Figure 3-1) until the cylindrical tube can be removed from the preamplifier. Figures 3-1 and 4-2 show the locations of the components.

Table 4-2 lists normal voltages from each transistor to ground. Measure the voltages with a vacuum-tube voltmeter and with a battery voltage of 21 volts. A 10-percent deviation from the listed values is allowable.

TABLE 4-2

PREAMPLIFIER TRANSISTOR VOLTAGES.

<i>Transistor</i>	<i>Terminal</i>	<i>Dc Volts to Ground</i>
Q101	DRAIN	21.0
	SOURCE	8.0
	GATE	8.1
Q102	COLLECTOR	16.6
	BASE	8.0
	EMITTER	7.5
Q103	COLLECTOR	11.5
	BASE	7.9
	EMITTER	7.3

Before making measurements, short-circuit the preamplifier input terminals. Install a resistor of about 10 megohms across resistor R101 (see Figures 4-2 and 4-3). If such a resistor is not available, momentarily short-circuit R101 before any voltages are measured. Do not attempt to measure the voltage from the gate of Q101 to ground without a shunt across resistor R101.

4.3.3 BATTERIES.

The Power supply is shipped with two 9.6-V batteries (Gould Type 9.6 V/225 B, or equivalent) installed.

MECHANICAL PARTS LIST

	Name	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
1	INPUT	Socket	4230-2693	24655	4230-2693	5935-911-2792
2	—	Dress Nut, 3/8, 7/16	5800-0805	24655	5800-0805	
3	—	Pilot Light, Lamp	5600-0314	71744	#344	6210-082-0583
4	—	Dress Nut, 15/32-32, 7/16	5800-0800	24655	5800-0800	5310-344-3644
5	CHECK	Switch	7870-1120	81073	30-1 N.O.	
6	—	Foot, Rigid, Stainless Steel	5250-1600	24655	5250-1600	

TYPE 1560-P40 PREAMPLIFIER PARTS LIST

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C101	Plastic, 0.0022 μ F $\pm 2\%$ 200 V	4860-7326	84411	663UW, 0.0022 μ F $\pm 2\%$	
C102	Electrolytic, 22 μ F $\pm 20\%$ 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
C103	Electrolytic, 120 μ F $\pm 20\%$ 10 V	4450-5616	56289	150D127X0010R2	
C104	Electrolytic, 120 μ F $\pm 20\%$ 10 V	4450-5616	56289	150D127X0010R2	
C105	Electrolytic, 120 μ F $\pm 20\%$ 10 V	4450-5616	56289	150D127X0010R2	
C106	Ceramic, 3.3 μ F $\pm 20\%$ 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
RESISTORS					
R101	Composition, 1 G Ω $\pm 20\%$ 1/2 W	6100-8108	01121	EB, 1 G Ω $\pm 20\%$	
R102	Composition, 27 k Ω to 150 k Ω $\pm 5\%$ 1/4 W	6099-*	75042		
R103	Composition, 20 k Ω $\pm 5\%$ 1/4 W	6099-3205	75042	BTS, 20 k Ω $\pm 5\%$	5905-686-3368
R104	Composition, 56 k Ω $\pm 5\%$ 1/4 W	6099-3565	75042	BTS, 56 k Ω $\pm 5\%$	5905-800-0179
R105	Composition, 51 k Ω $\pm 5\%$ 1/4 W	6099-3515	75042	BTS, 51 k Ω $\pm 5\%$	5905-200-6731
R106	Composition, 3 k Ω $\pm 5\%$ 1/4 W	6099-2305	75042	BTS, 3 k Ω $\pm 5\%$	5905-682-4097
R107	Film, 0.976 k Ω to 1.07 k Ω $\pm 1\%$ 1/8 W	6250-*	75042		
R108	Composition, 150 k Ω $\pm 5\%$ 1/4 W	6099-4155	75042	BTS, 150 k Ω $\pm 5\%$	5905-686-9995
R109	Film, 9.53 k Ω $\pm 1\%$ 1/8 W	6250-1953	75042	CEA, 9.53 k Ω $\pm 1\%$	5905-755-2759
R110	Composition, 39 Ω to 270 Ω $\pm 5\%$ 1/4 W	6099-*	75042		
R111	Composition, 8.2 k Ω $\pm 5\%$ 1/4 W	6099-2825	75042	BTS, 8.2 k Ω $\pm 5\%$	
R112	Composition, 6.2 k Ω $\pm 5\%$ 1/4 W	6099-2625	75042	BTS, 6.2 k Ω $\pm 5\%$	5905-682-4100
R113	Composition, 470 k Ω $\pm 5\%$ 1/4 W	6099-4475	75042	BTS, 470 k Ω $\pm 5\%$	
R114	Composition, 15 Ω $\pm 5\%$ 1/4 W	6099-0155	75042	BTS, 15 Ω $\pm 5\%$	
MISCELLANEOUS					
PL101	Plug	4220-5306	82389	G-4281	
SO101	Socket	1560-1400	24655	1560-1400	
S101	Switch, Toggle	7910-0830	82389	4663	
Q101	Transistor, C6601A	8210-1082	94589	D3068A	
Q102	Transistor, 2N3391A	8210-1092	24454	2N3391A	
Q103	Transistor, 4JX16A733	8210-1083	24454	4JX16A733	
TO168	Wrench	7985-1680	24655	7985-1680	
Spare Setscrews		1560-6250	24655	1560-6250	

*Value determined by General Radio Laboratory.

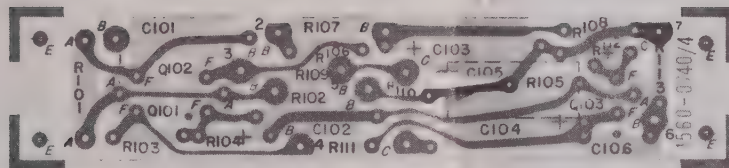


Figure 4-2. Etched-board layout for the Type 1560-P40 Preamplifier.

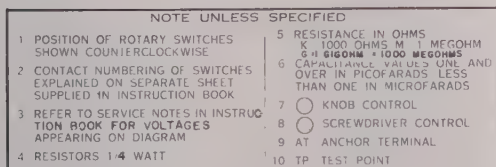


Figure 4-3. Schematic diagram for the Type 1560-P40 Preamplifier.

Value determined by General Radio Laboratory.

TYPE 1560-4100 POWER SUPPLY

PARTS LIST

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. S N
RESISTORS					
R501	Composition, 2.7 k Ω $\pm$ 5% 2 W	6120-2275	01121	HB, 2.7 k Ω $\pm$ 5%	
R502	Film, 7.68 k Ω $\pm$ 1% 1/8 W	6250-1768	75042	CEA, 7.68 k Ω $\pm$ 1%	5905-978-8817
R503	Film, 7.15 k Ω $\pm$ 1% 1/8 W	6250-1715	75042	CEA, 7.15 k Ω $\pm$ 1%	5905-815-3793
R504	Composition, 300 Ω $\pm$ 5% 1/4 W	6099-1305	75042	BTS, 300 Ω $\pm$ 5%	5905-279-5481
R505	Power, 6.8 k Ω $\pm$ 5% 5 W	6660-2685	80183	246E, 6.8 k Ω $\pm$ 5%	
MISCELLANEOUS					
B501	Battery, 9.6 V	8410-1040	09823	CD25	
B502	Battery, 9.6 V	8410-1040	09823	CD25	
CR501	Diode, 1N645	6082-1016	24446	1N645	5961-944-8222
CR502	Diode, 1N645	6082-1016	24446	1N645	5961-944-8222
CR503	Diode, 1N645	6082-1016	24446	1N645	5961-944-8222
CR504	Diode 1N645	6082-1016	24446	1N645	5961-944-8222
CR505	Diode, 1N957B	6083-1009	07910	1N957B	
J501	Jack, Output	4260-1030	82389	#111	
P501	Lamp, 10 V	5600-0314	71744	#344	6210-082-0583
PL501	Plug, Power, Input for Charger	4240-0702	24655	4240-0702	5935-993-9847
SO501	Socket, Input	4230-2693	24655	4230-2693	5935-911-2792
S501	Switch, Battery On/Charge	7910-1500	04009	83054-SA	5930-797-3760
S502	Switch, Check	7870-1120	81073	30-1 N.O.	
S503	Switch, Line Voltage Selector	7910-0831	42190	4603	
Q501	Transistor, 2N2714	8210-1047	24446	2N3416	5961-989-2749
T501	Transformer	0748-4000	24655	0748-4000	
CAP22	Power Cable	4200-9622	24655	4200-9622	6150-968-0081

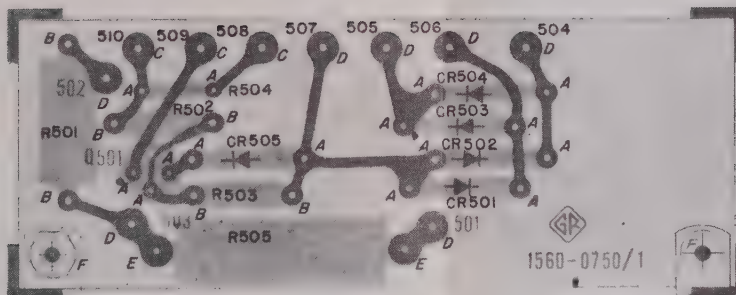


Figure 4-4. Etched-board layout for the Type 1560-4100 Power Supply.

NOTE

The number shown on the foil side of the board is not the part number for the complete assembly. The assembly number is 1560-2751.

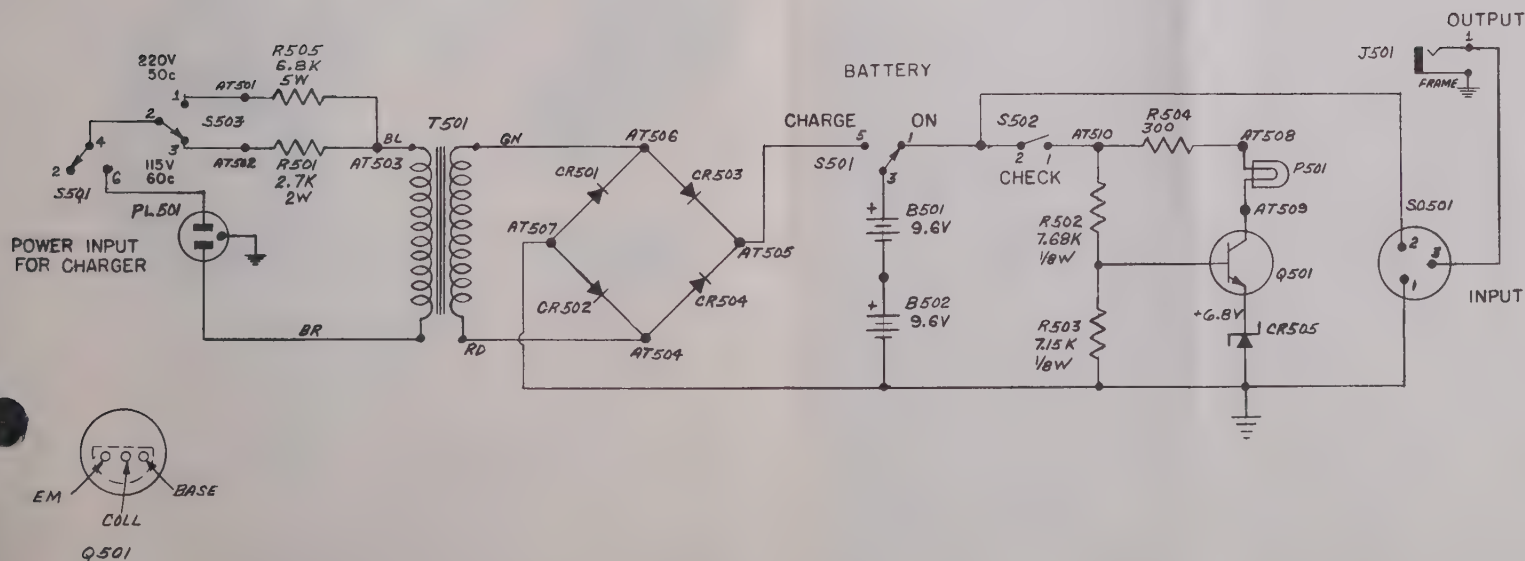


Figure 4-5. Schematic diagram for the Type 1560-4100 Power Supply.

APPENDIX

CABLES AND ADAPTORS FOR USE WITH THE TYPE 1560-P40 PREAMPLIFIER

Type 1560-P72, 25-foot Cable

Connects the preamplifier to the Type 1560-4100 Power Supply or measuring instrument supplying power; also carries output signal from the preamplifier to a phone jack on the Type 1560-4100 Power Supply or to the measuring instrument.

Type 1560-P72C, 4-foot Cable

Same as Type 1560-P72 Cable, above, except for length.

Type 1560-P95 Adaptor Cable

Provides means of connecting the preamplifier output signal from a jack on the Type 1560-4100 Power Supply, through a cable, to a Type 274-M Double Plug.

Type 1560-P99 Adaptor Cable

Cable with phone plug on one end and 3-terminal, shielded, audio connector on the other.

Type 1560-P96 Adaptor

Adapts preamplifier input to 3-terminal, shielded audio connector.

Type 1560-P97 Adaptor

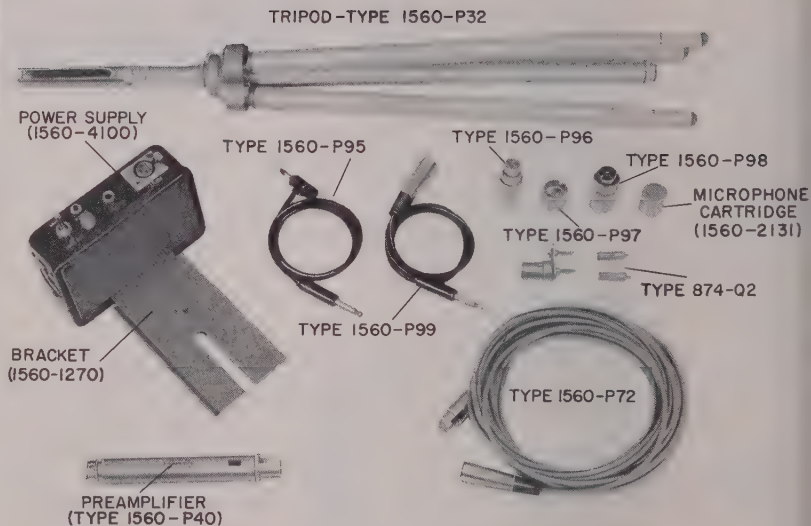
Adapts preamplifier input to cartridge of Type 1560-P3 Microphone.

Type 1560-P98 Adaptor

Adapts preamplifier input to GR874 Coaxial Connector.

Type 874-Q2 Adaptor

Adapts GR874 Coaxial Connector to Type 274 Jacks (banana-pin) on 3/4-inch spacing.



AVAILABLE COMBINATION SETS

The Type 1560-P40 Preamplifier is available with various accessories in the three sets listed below (see figure, page 22).

Type 1560-P40H Preamplifier and Power Supply Set

This set is self-powered; it is independent of any external power supply. It can be used with the Type 1565-A Sound-Level Meter or with any of the instruments listed in Table 3-3.

The following items are included in the Type 1560-P40H Preamplifier and Power Supply Set:

Type 1560-P40 Preamplifier	Type 1560-P72C 4-foot Cable
Type 1560-4100 Power Supply	Type 874-Q2 Adaptor
Type 1560-P96 Adaptor	Carrying Case 1560-0421
Type 1560-P98 Adaptor	Spare Setscrews 1560-6250
Type 1560-P95 Adaptor Cable	Wrench 7985-1680
Type 1560-P99 Adaptor Cable	

Type 1560-P40J Preamplifier and Adaptor Set

Power for the preamplifier, with this set, must be obtained from the instrument to which the preamplifier is connected, such as the Types 1558 and 1564 Analyzers; other instruments, such as the Type 1551 Sound-Level Meter and the Type 1553 Vibration Meter, must be modified to provide power for the preamplifier (refer to paragraphs 2.3, 2.4, and 2.5). If the source connector is not a type for which an adaptor is supplied, the GR874 Adaptors (listed in the General Radio Catalog) can be used with the Type 1560-P98 Adaptor (supplied) to mate with most standard coaxial connectors.

The following items are included in the Type 1560-P40J Preamplifier and Adaptor Set:

Type 1560-P40 Preamplifier	Type 1560-P72C 4-foot Cable
Type 1560-P96 Adaptor	Carrying Case 1560-0421
Type 1560-P97 Adaptor	Spare Setscrews 1560-6250
Type 1560-P98 Adaptor	Wrench 7985-1680

Type 1560-P40K Preamplifier and Microphone Set

This set is intended for use with Types 1558 and 1564 Analyzers when an acoustic measurement is to be made at low levels or when the microphone must be located at the end of a long cable. This set can also be used with a modified Type 1551-C Sound-Level Meter (refer to paragraph 2.3) when a long microphone cable is necessary.

The following items are included in the Type 1560-P40K Preamplifier and Microphone Set:

Type 1560-P40 Preamplifier	Type 1560-2131 Microphone
Type 1560-P72C 4-foot Cable	Cartridge
Type 1560-P72 25-foot Cable	Carrying Case 1560-0421
Type 1560-P32 Tripod	Spare Setscrews 1560-6250
	Wrench 7985-1680

Type 1560-9512 Power Supply Group

The following Power Supply Group is also available:

Type 1560-4100 Power Supply	Type 1560-1270 Bracket
Type CAP-22 Three-wire Power Cord	

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1
(Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer	Code	Manufacturer	Code	Manufacturer
00092	James Mfg. Co., Chicago, Illinois	48971	RCA, New York, N.Y. 10020	80431	Air Filter Corp., Milwaukee, Wis., 53218
00094	Waco Electronics Corp., L.A., Calif.	49956	Raytheon Mfg. Co., Waltham, Mass. 02154	80583	Hammann & Co., Inc., New York, N.Y.
00434	Schwab Electronics, Westinghouse, L.I., N.Y.	53021	Sangamo Electric Co., Springfield, Ill. 62708	80740	Beckman Instruments, Inc., Fullerton, Calif.
00486	Aerovox Corp., New Bedford, Mass.	54294	Shallcross Mfg. Co., Selma, N.C.	81030	International Instrument, Orange, Conn.
01009	Alcon Products Co., Brockton, Mass.	54715	Shure Brothers, Inc., Evanston, Ill.	81073	Grayhill Inc., LaGrange, Ill. 60528
01121	Allen-Bradley Co., Milwaukee, Wis.	56289	Sprague Electric Co., N. Adams, Mass.	81143	Isolantite Mfg. Corp., Stirling, N.J. 07980
01295	Texas Instruments, Inc., Dallas, Texas	59730	Thomas and Beta Co., Elizabeth, N.J. 07207	81549	Military Specifications
02114	Farcouche Corp., Saugerties, N.Y. 12477	59875	TRW Inc. (Acescoris Div.), Cleveland, Ohio	81350	Joint Army-Navy Specifications
02560	Fenwal Lab Inc., Torrington Grove, Ill.	60399	Torrington Mfg. Co., Torrington, Conn.	81781	Columbus Electronics Corp., Yonkers, N.Y.
02660	Amphenol Electric Corp., Broadview, Ill.	61637	Union Carbide Corp., New York, N.Y. 10017	81831	Filtron Co., Rushing, N.Y. 11354
02768	Festec, Des Plaines, Ill. 60016	61864	United-Carr Fastener Corp., Boston, Mass.	81840	Ledex Inc., Dayton, Ohio 45402
03058	G.E. Saniicon Prod., Syracuse, N.Y. 13201	63600	Victoreen Instrument Co., Inc., Cleveland, O.	81860	Berry-Wright Corp., Watertown, Mass.
03508	Grayburn, Yonkers, N.Y. 10701	63743	Ward Leonard Electric Co., Mt. Vernon, N.Y.	82219	Solar Electric Corp., Warren, Penn.
03666	Pyrofilm Resistor Co., Cedar Knolls, N.J.	65003	Westinghouse (Lamp Div.), Bloomfield, N.J.	82273	Indiana Pattern & Model Works, LaPort, Ind.
03988	Claires Corp., New York, N.Y. 10011	65002	Weston Instruments, Newark, N.J.	82389	Schwartzkopf & Co., Chicago, Ill. 60630
04001	Arrow-Hart & Hegeman, Hartford, Conn. 06106	70485	Atlantic-India Rubber, Chicago, Ill. 60607	82647	Messle & Controls Inc., Amherst, Mass.
04713	Motolora, Phoenix, Ariz. 85006	70563	Amperite Co., Union City, N.J. 07087	82807	Milwaukee Resistor Co., Milwaukee, Wis.
05170	Eng'g Electronics, Santa Ana, Calif. 92702	70903	Belen Mfg. Co., Chicago, Ill. 60644	83033	Melaner Mfg. (Maguire Ind.) Mt. Carmel, Ill.
05624	Barber-Colman Co., Rockford, Ill. 61101	71126	Bronson, Homer D. Co., Beacon Falls, Conn.	83058	Carr Fastener Co., Cambridge, Mass.
05620	Wackfield Eng. Inc., Wakefield, Mass. 01880	71294	Canfield, H.O. Co., Clifton Forge, Va. 24422	83186	Victory Engineering, Springfield, Ill. 62701
07126	Digatron Co., Pasadena, Calif.	71400	Bussman (McGraw Edison), St. Louis, Mo.	83261	Bearing Specialty Co., San Francisco, Calif.
07127	Exyte Signal (E.W. Bille Co.), Baraboo, Wis.	71468	ITT Cannon Elec., L.A., Calif. 90031	83270	John Electric Corp., Warren, Penn.
07261	Avnet Corp., Culver City, Calif. 90230	71590	Centralab, Inc., Milwaukee, Wis. 53212	83740	Union Carbide Corp., New York, N.Y. 10017
07263	Fairchild Camera, Mountain View, Calif.	71866	Continental Carbon Co., Inc., New York, N.Y.	83781	National Electronics Inc., Geneva, Ill.
07387	Birtcher Corp., No. Los Angeles, Calif.	71707	Coto Coll Co. Inc., Providence, R.I.	84411	TRW Capacitor Div., Cagidale, N.Y.
07589	Amer Semicond., Arlington Heights, Ill. 60004	71744	Chicago Miniature Lamp Works, Chicago, Ill.	84835	Lehigh Metal Froth, Cambridge, Mass. 02140
07598	Bodine Corp., Bridgeport, Conn. 06605	71785	Cinch Mfg. Co., Chicago, Ill. 60624	84971	T-A Mfg. Corp., Los Angeles, Calif.
07820	Bodine Electric Co., Chicago, Ill. 60618	71823	Dannell Corp., Ltd., Downey, Calif. 90241	85065	Practical Metal Co., Harrison, Mass. 02180
07919	Con Dvice Corp., Hawthorne, Calif.	72136	Electro Motive Mfg. Co., Wilmington, Conn.	86684	RCA (Elect. Comm. Div.), Hicksville, N.J.
07983	Stene Labs Inc., N.Y., N.Y. 10003	72259	Nytronics Inc., Berkeley Heights, N.J. 07922	86687	REC Corp., New Rochelle, N.Y. 10801
07999	Borg Int., Delavan, Wis. 53116	72699	General Instr. Corp., Newark, N.J. 07104	86800	Con Electronics Corp., Trenton, N.J. 11222
08273	Vernaline Prod. Co., Franklin Lakes, N.J.	72765	Drake Mfg. Co., Chicago, Ill. 60686	88140	Cummins-ten-ten Inc., Lincoln, Ill.
08313	G.E. Semiconductor, Buffalo, N.Y.	72825	Hugh H. Eby Inc., Philadelphia, Penn. 19144	88219	Gould Net. Batteries Inc., Brooklyn, N.Y.
08408	Star-Tronics Inc., Georgetown, Mass. 01830	72962	Elastic Stop Nut Corp., Union, N.J. 07083	88419	Cornell-Quillier, Piquette, Van Nuys, N.C.
08523	Burgess Battery Co., Freeport, Ill.	72982	Erie Technological Products Inc., Erie, Penn.	88627	R & G Mfg. Co., New York, N.Y.
08522	Burns Corp., Norwalk, Conn. 06852	73138	Beckman Inc., Fullerton, Calif. 92634	89822	Holtzer-Cabot Corp., Boston, Mass.
11236	C.T.S. of Berns, Inc., Berns, Ind. 46711	73445	Amperex Electronics Co., Hicksville, N.Y.	90201	United Transformer Co., Chicago, Ill.
11599	Chandler Electronics Corp., W. Hartford, Conn.	73559	Carling Electric Co., W. Hartford, Conn.	90760	Hallory Capacitor Co., Indianapolis, Ind.
12040	National Semiconductor, Danbury, Conn.	73590	Eico Resistor Co., New York, N.Y.	90952	Westinghouse Electric Corp., Boston, Mass.
12498	Crystalline, Cambridge, Mass. 02140	73899	JFD Electronics Corp., Brooklyn, N.Y.	91032	Hardware Products Co., Heading, Penn. 19602
12672	RCA, Woodbridge, N.J.	74193	Heinemann Electric Co., Trenton, N.J.	91146	Continental Wire Corp., York, Penn. 17406
12697	Claroets Mfg. Co., Inc., Dover, N.H. 03820	74661	Industrial Condenser Corp., Chicago, Ill.	91468	ITT (Cannon Electric Inc.), Salem, Mass.
12954	Dickson Electronics, Scottsdale, Ariz.	74970	E.F. Johnson Co., Waseca, Minn. 56093	91506	Johnson Mfg. Co., Boonton, N.J. 07008
13382	Solliton Devicex, Tappan, N.Y. 10983	75042	IRC Inc., Philadelphia, Penn. 19108	91598	Chandler Co., Wethersfield, Conn. 06109
14423	ITT Semiconductors, W. Palm Beach, Fla.	75382	Kulite Electric Corp., Mt. Vernon, N.Y.	91627	Dale Electronics Inc., Columbus, Nebr.
14656	Cornell-Dubilier Electric Co., Newark, N.J.	75491	Lafayette Industrial Electronics, Jamaica, N.Y.	91662	Eico Corp., Willow Grove, Penn.
14674	Corning Glass Works, Corning, N.Y.	75608	Linden and Co., Providence, R.I.	91719	General Instruments, Inc., Dallas, Texas
14636	General Instrument Corp., Hicksville, N.Y.	75915	Littellus Inc., Des Plaines, Ill. 60016	91762	Honeywell Inc., Freeport, Ill.
15238	ITT Semiconductor Div., Lawrence, Mass.	76049	Long Mfg. Co., Erie, Penn. 16512	92219	Electra Inad Corp., Woodville, La., N.Y.
15605	Cutler-Hammer Inc., Milwaukee, Wis. 53233	76105	Mallory Electric Corp., Detroit, Mich. 48204	92678	E.O.G.B., Boston, Mass.
16037	Sorce Pine Mica Co., Sorce Pine, N.C.	76467	James Millen Mfg. Co., Malden, Mass. 02148	93332	Sylvania Elect. Prods. Inc., Woburn, Mass.
17371	Singer Co., Diah Di, Somerville, N.J.	76545	Mueller Electric Co., Cleveland, Ohio 44114	93916	Cramer Products Co., New York, N.Y. 10013
19396	Illinois Tool Works, Fiskton Div., Chicago, Ill.	76684	National Tube Co., Pittsburgh, Penn.	94144	Raytheon Co., Components Div., Quincy, Mass.
19544	LPC Electronics, Homestead, N.Y.	76854	Oak Mfg. Co., Crystal Lake, Ill.	94154	Tung Sol Electric Inc., Newark, N.J.
19701	Electra Mfg. Co., Independence, Kansas 67301	77147	Peterson MacGyver Co., Providence, R.I.	95076	Gardes Mfg. Co., Cumberland, R.I.
21335	Fahrer Bearing Co., New Britain, Conn.	77186	Pas-Seymour, Syracuse, N.Y.	95121	Quality Components Inc., St. Mary's, Penn.
22753	UID Electronics Corp., Hollywood, Fla.	77263	Pierce Roberts Rubber Co., Trenton, N.J.	95146	Ade Electronics Mfg. Co., Lawrence, Mass.
23242	Amer Electronics Corp., Franklin Park, Ill.	77339	Positive Lockwasher Co., Newark, N.J.	95238	Continental Connector Corp., Woodville, N.Y.
24444	G.E., Schenectady, N.Y. 12306	77842	Ray-D-Vac Co., Madison, Wis.	95275	Vitronum, Inc., Bridgeport, Conn.
24454	G.E., Electronics Corp., Syracuse, N.Y.	77630	TRW, Electronic Corp., Camden, N.J. 08103	95354	Methods Mfg. Co., Chicago, Ill.
24655	G.E. (Lamp Div.), Nela Park, Cleveland, Ohio	77638	General Instruments Corp., Brooklyn, N.Y.	95412	General Electric Co., Schenectady, N.Y.
24655	General Radio Co., W. Concord, Mass. 01781	78189	Shakeproof (Ill. Tool Works), Elgin, Ill. 60120	95494	Anacosta Amer Brass Co., Torrington, Conn.
26806	American Zentel Inc., Costa Mesa, Calif.	78277	Sigma Instruments Inc., S. Braintree, Mass.	95605	Microvase Associates Inc., Burlington, Mass.
28520	Hayman Mfg. Co., Kenilworth, N.J.	78488	Stackpole Carbon Co., St. Marys, Penn.	96791	Amphenol Corp., Jansenville, Wis. 53446
28859	Hoffman Electronics Corp., El Monte, Calif.	78553	Tinnerman Products, Inc., Cleveland, Ohio	96906	Military Standards
30974	I.B.M. Armonk, New York	79089	RCA, Rac Tube & Semicond., Harrison, N.J.	98251	Sesactec Corp., Manassas, N.Y. 10844
32001	Jensen Mfg. Co., Chicago, Ill. 60631	79725	Wiremold Co., Hartford, Conn. 06110	98474	Compac Inc., Burlington, Calif.
33173	G.E. Comp. Ovensboro, Ky. 40306	79953	Zierick Mfg. Co., New Rochelle, N.Y.	98821	North Hills Electronics Inc., Glen Cove, N.Y.
35928	Constants Co., Mont. 19, 19	80030	Prestole Fastener, Toledo, Ohio	98821	Translition Electronics Corp., Melrose, Mass.
37942	P.R. Mallory & Co. Inc., Indianapolis, Ind.	80048	Vickers Inc., St. Louis, Mo.	99313	Terlan, Palo Alto, Calif. 94303
38643	Marlin-Rockwell Corp., Jamestown, N.Y.	80131	Electronic Industries Assoc., Washington, D.C.	99378	Atlas Corp., Winchester, Mass. 01890
40331	Honeywell Inc., Minneapolis, Minn. 55408	80183	Siragusa Products Co., No. Adams, Mass.	99800	Delavan Electronics Corp., E. Aurora, N.Y.
42190	Muster Co., Chicago, Ill. 60638	80211	Motrola Inc., Franklin Park, Ill. 60131		
42498	National Co., Inc., Melrose, Mass. 02176	80298	Standard Oil Co., Lafayette, Ind.		
43991	Norme-Hoffman, Stamford, Conn. 06904	80294	Bourne Inc., Riverside, Calif. 92508		



GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS 01781

617 369-4400

617 646-7400

DISTRICT OFFICES

METROPOLITAN NEW YORK *

845 Broad Avenue
Ridgefield, New Jersey 07657
Telephone N.Y. 212 964-2722
N.J. 201 943-3140

SYRACUSE

Pickard Building
East Molloy Road
Syracuse, New York 13211
Telephone 315 454-9323

NEW ENGLAND *

22 Baker Avenue
West Concord, Massachusetts 01781
Telephone 617 646-0550

PHILADELPHIA

Fort Washington Industrial Park
Fort Washington, Pennsylvania 19034
Telephone 215 646-8030

WASHINGTON * AND BALTIMORE

11420 Rockville Pike
Rockville, Maryland 20852
Telephone 301 946-1600

ORLANDO

113 East Colonial Drive
Orlando, Florida 32801
Telephone 305 425-4671

CHICAGO *

9440 W. Foster Avenue
Chicago, Illinois 60656
312 992-0800

CLEVELAND

5579 Pearl Road
Cleveland, Ohio 44129
Telephone 216 886-0150

LOS ANGELES *

1000 North Seward Street
Los Angeles, California 90038
Telephone 213 469-6201

SAN FRANCISCO

626 San Antonio Road
Mountain View, California 94040
Telephone 415 948-8233

DALLAS *

2600 Stemmons Freeway, Suite 210
Dallas, Texas 75207
Telephone 214 637-2240

TORONTO *

99 Floral Parkway
Toronto 15, Ontario, Canada
Telephone 416 247-2171

MONTREAL

100 Boulevard
Mont Royal, Quebec, Canada
514 737-3673
Telephone 613 233-4237

* Repair services are available
at these district offices.

www.manualsplus.com



1019914

General Radio
General Radio Company
Representative

Switzerland
Berkshire, England
eries